

Integrating Green Technologies and Strategies into Site Remediation

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SAM Fall Meeting
September 17, 2008
San Diego, CA



California Department of
Toxic Substances Control

DTSC's Green Remediation Team

- **Initiated in February 2007**
- **Eight staff participate**
- **Meet routinely, work on deliverables in between meetings**

DTSC's Green Remediation Team

- **Initiative to promote the use of green technologies and strategies in site remediation work**
- **Green remedies and technologies are least disruptive to the environment, recyclable, and emit fewer pollutants and greenhouse gases to the atmosphere**

Green Remediation Team Goals

- **Define Green Remediation**
- **Develop Evaluation Tool(s)**
- **Develop Training for Staff**
- **Invite Technology Presentations**
- **Identify Incentives to use Green Technologies**
- **Publicize Efforts**
- **Legislative proposals**

Conventional Remediation

- **Focuses on Endpoints**
 - **Protect or restore water resources**
 - **Reduce or eliminate hazardous substance risk**
 - **Restore property to developable condition**
- **Remedies Not Always Sustainable**
 - **Natural resources extracted, used in project**
 - **Recycling, reuse of materials rarely considered**

Conventional Remediation (cont.)

- **Energy Use Not Considered**
 - **Transportation to and from site**
 - **On and off-site operations**
- **Greenhouse Gas, Other Substances Emitted**
 - **Heavy vehicle traffic**
 - **On-site construction**
 - **Long term remedy operations**

Green Remediation

- **Remains Endpoint Focused**
- **Examine Impacts Beyond Site Boundaries**
- **Considers Impacts Not Always Addressed Under RCRA, CERCLA**
 - **Consumption of energy, raw materials**
 - **Greenhouse gas and other emissions**
 - **Impacts over life of remedy**

DTSC's Green Remediation Team

- **Initially focused on alternative energy sources such as bio-diesel and solar**
- **Recognized the difficulty of separating the technology from the remedy**
- **Expanded our interests to include broader range of considerations in remediation and remedy evaluation**

DTSC's Green Remediation Team

- **Not facilitating the 'no action' alternative**
- **Not focusing on monitored natural attenuation**
- **Not facilitating capping and containment**

Early Efforts

- **Literature review produced limited results**
- **Needed to define 'Green'**
- **First cut at a basic rating matrix**

Early Matrix Factors

- **Energy Consumption**
- **Liquid and Solid Waste Production**
- **Air Quality**
 - **Regulated pollutants**
 - **Non-regulated pollutants, greenhouse gases**
- **Product Utilization, Including Recycling**

Early Matrix Factors (cont.)

- **Community Benefits**
- **Duration Required**
- **Treatment Effectiveness**
- **Life-Cycle Cost**
- **Worker Safety**

First Matrix Attempt

Treatment Alternatives--Soil

	Containment	Excavation & Disposal	Bioventing	Containment (Capping)	Bioventing and Excavation
Raw Materials Extraction					
Energy Consumption					
Liquid Waste Production					
Solid Waste Production					
Air Quality Impacts					
Greenhouse Gas Production					
Other Contaminants					
Virgin Materials/Ore Extraction					
Quantity Extracted					
Utilizability fraction					
Renewable resource fraction					
Worker Safety					
Community Benefits					
Cost					
Manufacturing					
Energy Consumption					
Liquid Waste Production					
Solid Waste Production					
Air Quality Impacts					
Greenhouse Gas Production					
Other Contaminants					
Raw Materials Utilization					
Consumption					
Recycling/reuse Potential					
Worker Safety					
Community Benefits					
Cost					
Point of Use					
Energy Consumption					
Liquid Waste Production					
Solid Waste Production					
Air Quality Impacts					
Greenhouse Gas Production					
Other Contaminants					
Product Utilization					
Recycling/reuse Potential					
Worker Safety					
Community Benefits					
Duration Required					
Effectiveness in Reaching Treatment Objective					
Life-Cycle Cost					

Treatment Alternatives--Groundwater

[illegible]

Lessons Learned from First Attempt

- **Too detailed, no system boundaries**
- **Discussions bogged down in the details**
- **Went back to the drawing board to find a 'better' approach**

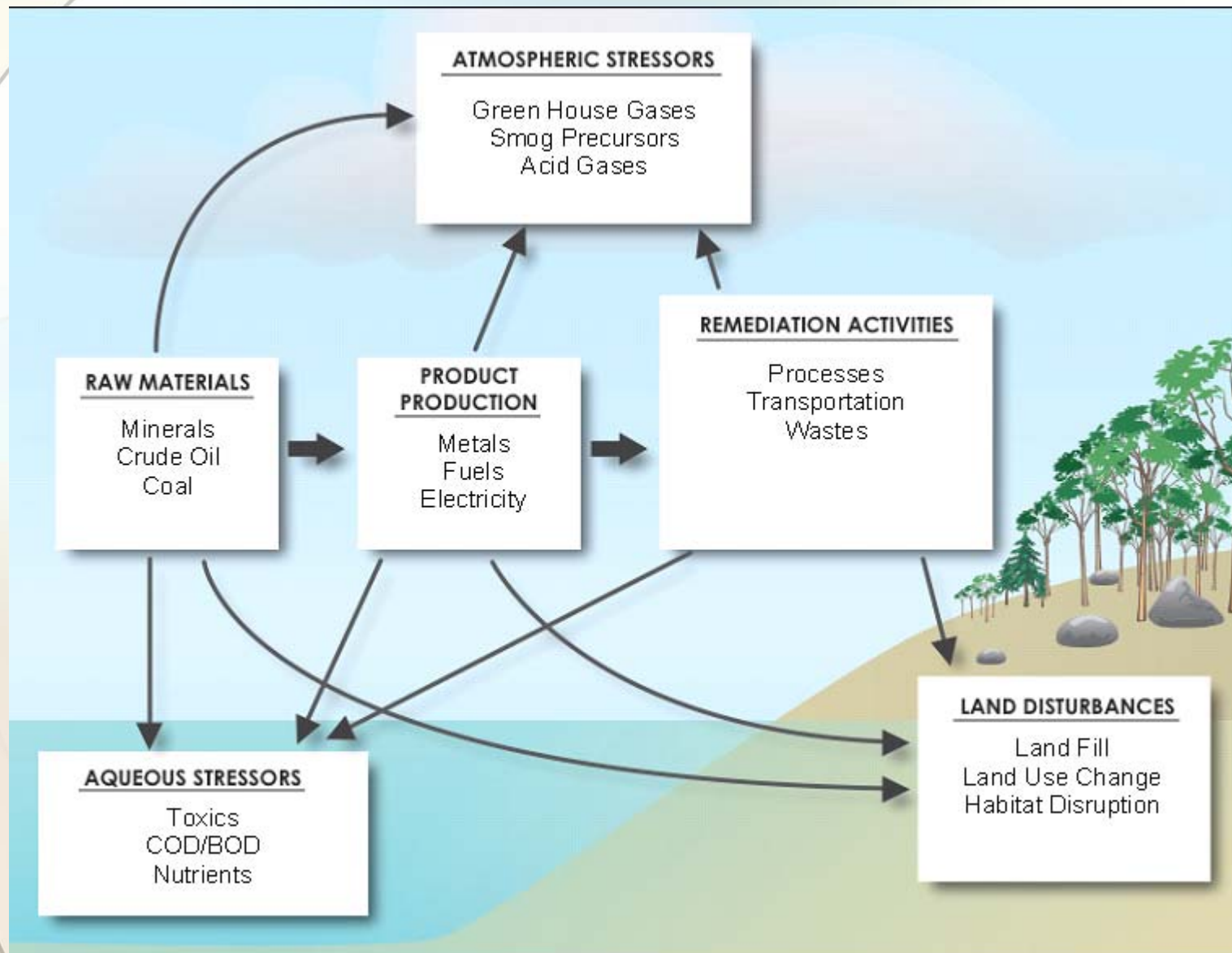
Life-Cycle Framework

- **Life Cycle Assessment – detailed, quantitative**
- **Life Cycle Management – not so detailed, qualitative**
- **Major Reference – Diamond and Page, Environmental Toxicology and Chemistry, 1999**

Life Cycle Assessment

- **Offers a methodology for ‘cradle-to cradle’ evaluation**
- **Considers on-site and off-site impacts**
- **Could become more cumbersome than other aspects of remedy process combined**

Life-Cycle Framework



Green Remediation Evaluation Matrix (GREM)

Stressors	Affected Media	Mechanism/ Effect	Y/N	Score
Substance release/production				
Airborne NOx & SOx	Air	Acid rain & Photochemical smog		
Chloro-fluorocarbon vapors	Air	Ozone Depletion		
Greenhouse gas emissions	Air	Atmospheric warming		
Airborne particulates/Toxic vapors/gases/Water vapor	Air	Gen Air Pollution/Toxic air/Humidity increase		
Liquid waste production	Water	water toxicity/sediment toxicity/sediment		
Solid waste production	Land	Land use/toxicity		
Thermal releases				
Warm water	Water	Habitat warming		
Warm vapor	Air	Atmospheric humidity		
Physical disturbances/disruptions				
Soil structure disruption	Land	Habitat destruction/ Soil Infertility		
Noise/Odor/Vibration	Gen Env	Nuisance & Safety		
Traffic	Land; Gen Env	Nuisance & Safety		
Land Stagnation	Land; Gen Env	Remediation time; Cleanup efficiency;re-development		
Resource Depletion/Gain (Recycling)				
Petroleum (energy)	Subsurface	Consumption		
Mineral	Subsurface	Consumption		
Construction material	Land	Consumption/reuse		
Land & space	Land	Impoundment/reuse		
Surface water & groundwater	Water, Land (subsidence)	Impoundment/ Sequester/reuse		
Biology Resources (Plants/trees/animals/microorganisms)	Air, Water, Land, Subsurface	Species Disappearance/ Diversity Reduction Regenerative Ability Reduction		

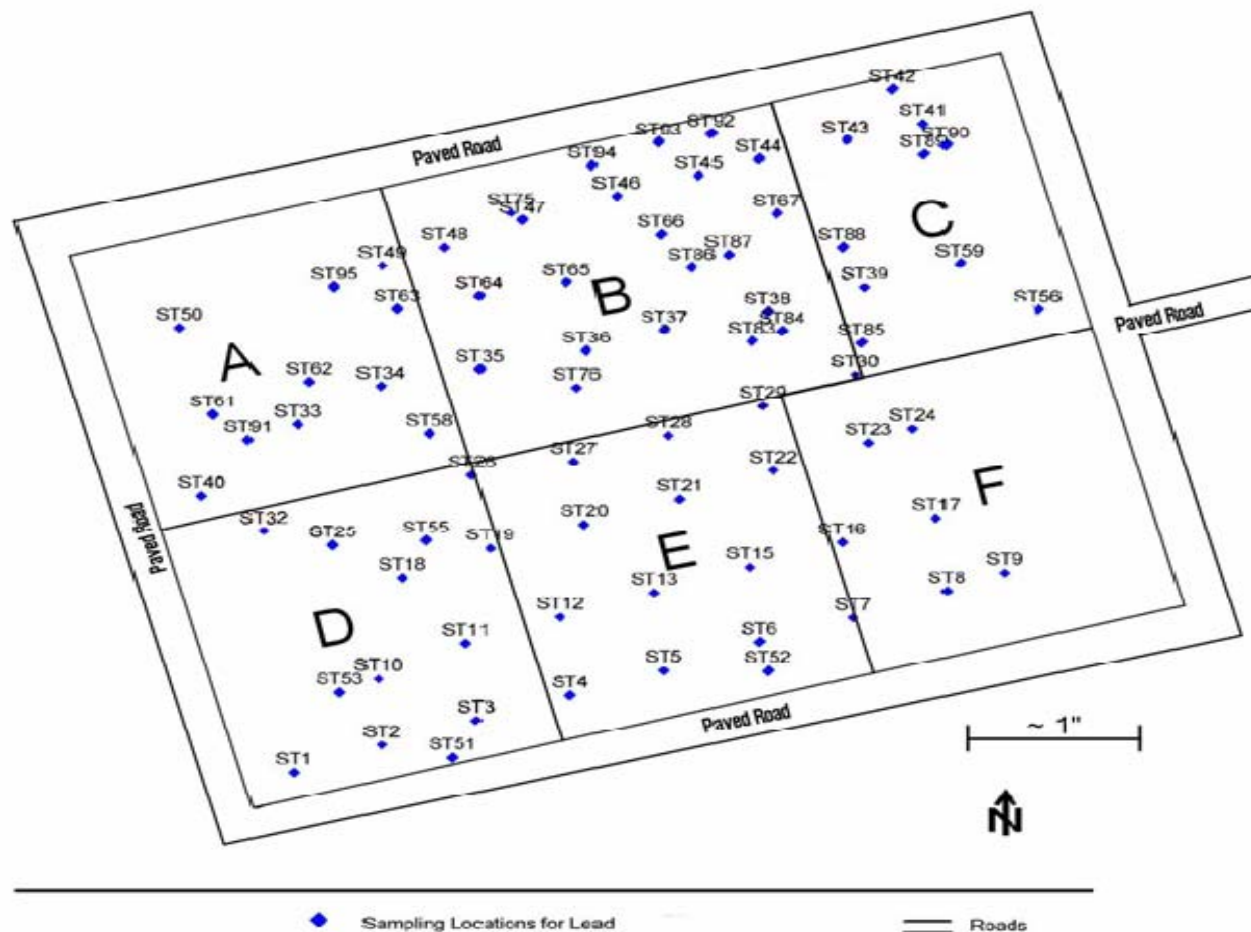
Next Steps

- **Finalize matrix, prepare guidance document**
- **Pilot Projects**
- **DTSC Symposium Planned February 2009**
- **Continue working with Sustainable Remediation Forum (SURF)**
- **Staff Training**
- **Potential changes – regulation, incentives?**

Pilot Project

- **Currently participating in a pilot project for a PCE site**
- **Considering energy and environmental parameters for site characterization**
- **So far, this appears to be the first look at sustainability in site sampling and characterization**

A Site Remediation Example – One Outcome



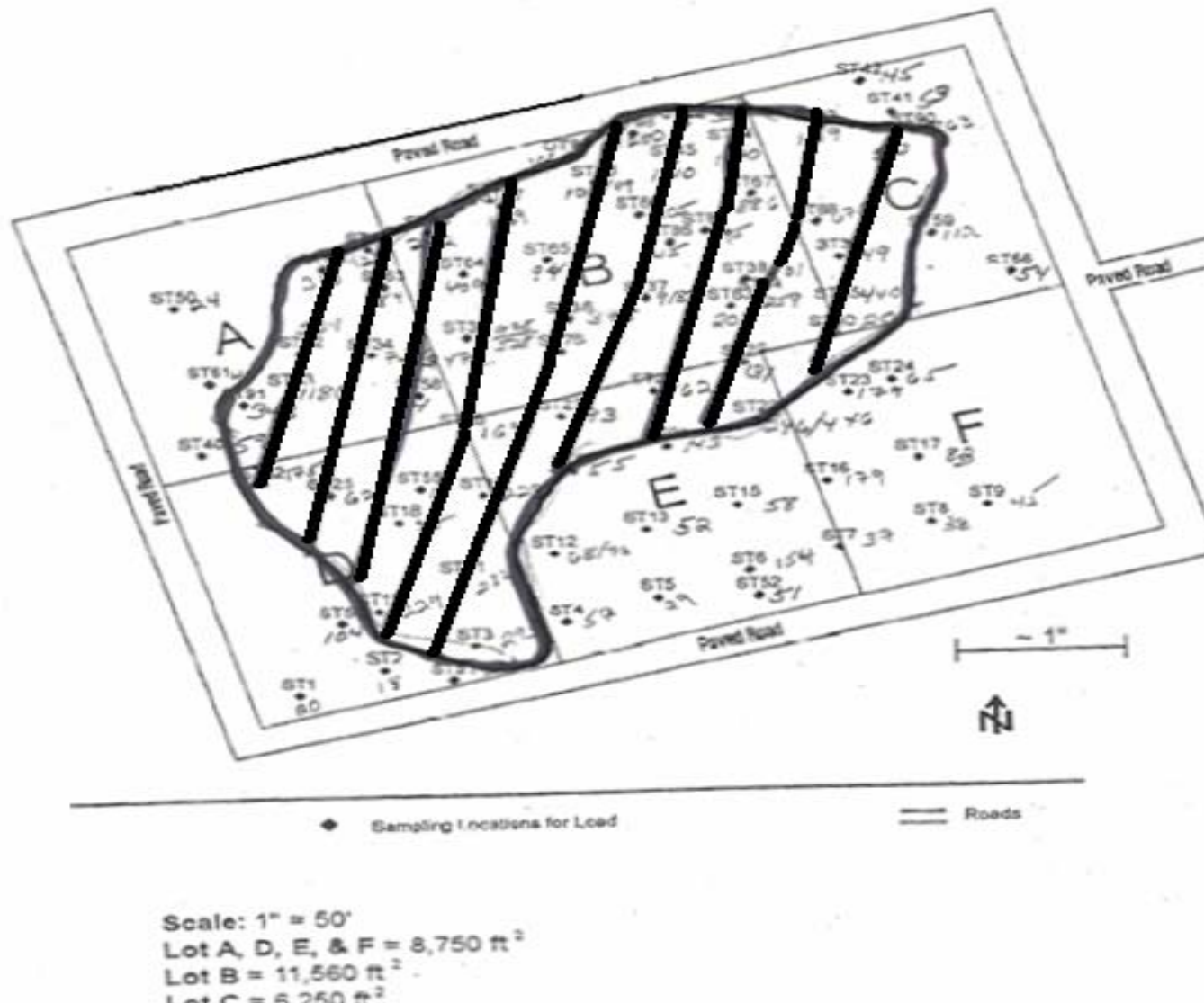
Scale: 1" = 50'

Lot A, D, E, & F = 8,750 ft²

Lot B = 11,560 ft²

Lot C = 6,250 ft²

Same Site – Another Outcome



References and Contact Info

- **Use of Risk Assessment in Management of Contaminated Sites; ITRC, Aug. 2008**
- **http://www.itrcweb.org/Documents/Risk_Docs/RISK2.pdf**
- **Paul Hadley**
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Where Do We Go From Here?



Acknowledgements

- **Bob Boughton**
- **Ning-Wu Chang**
- **Mikos Fabersunne**
- **Tayseer Mahmoud**
- **Charlie Ridenour**
- **Chris Parent**
- **John Scandura**